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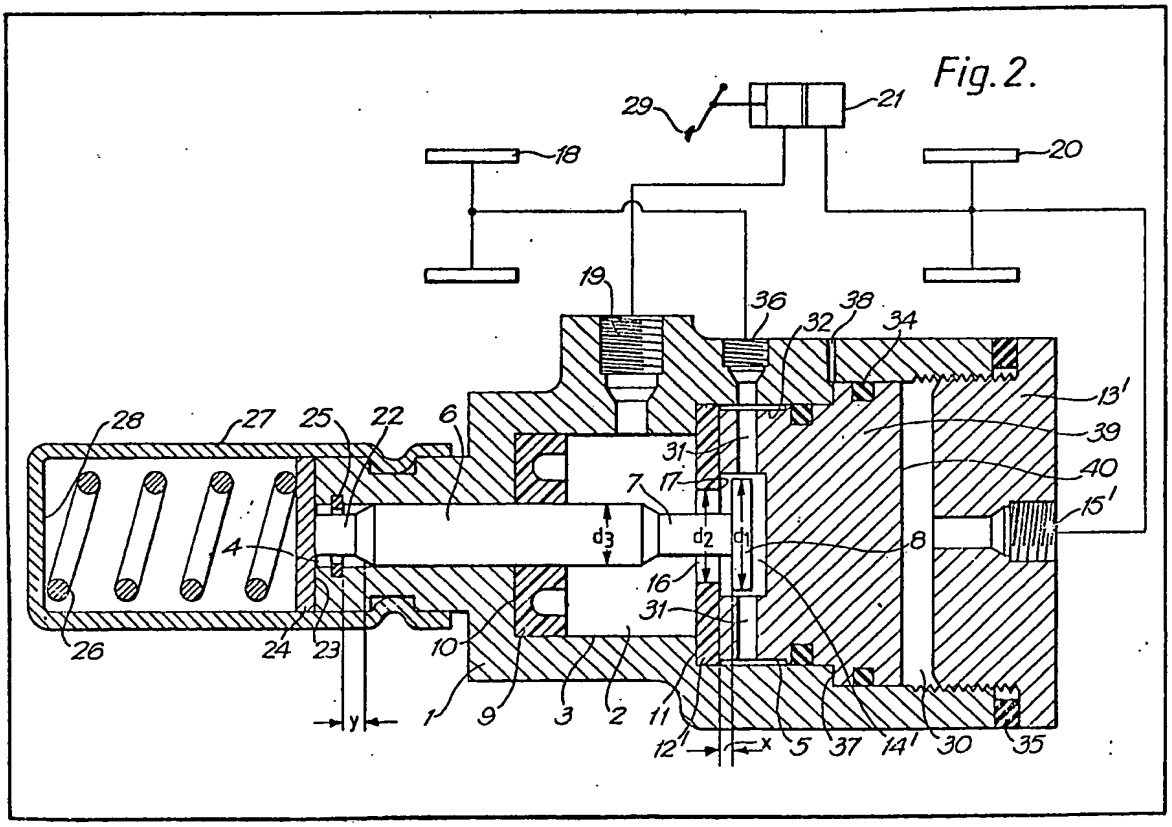
(54) **Brake Pressure Regulator**

(57) A brake pressure regulator including an inlet 2 and an outlet chamber 36 separated by an elastomeric valve seat ring 12, which is closable, by a valve plate 8 carried by a valve piston 6. In dependence on the relationship between the diameters $d_1$ and $d_3$, the regulator can be a brake pressure reducer (as shown) or a brake pressure limiter ($d_3=d_1$). When the pressure in the inlet chamber is decreased below that in the outlet chamber, the valve seat ring 12 is deformed into the inlet chamber 2 thereby re-opening passage 16 for pressure compensation. Movement of the valve plate 8 is limited by a stop 25 which engages the piston 6. The valve seat ring 12 is fixed between a shoulder 11 and a screwed plug or as shown, a piston is interposed between the ring and the plug 13', the piston being urged towards the ring by the pressure in the other brake circuit to that in which the pressure is regulated, so that upon failure of the other brake circuit the effect of the regulator is neutralized.

The drawing(s) originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig. 2.

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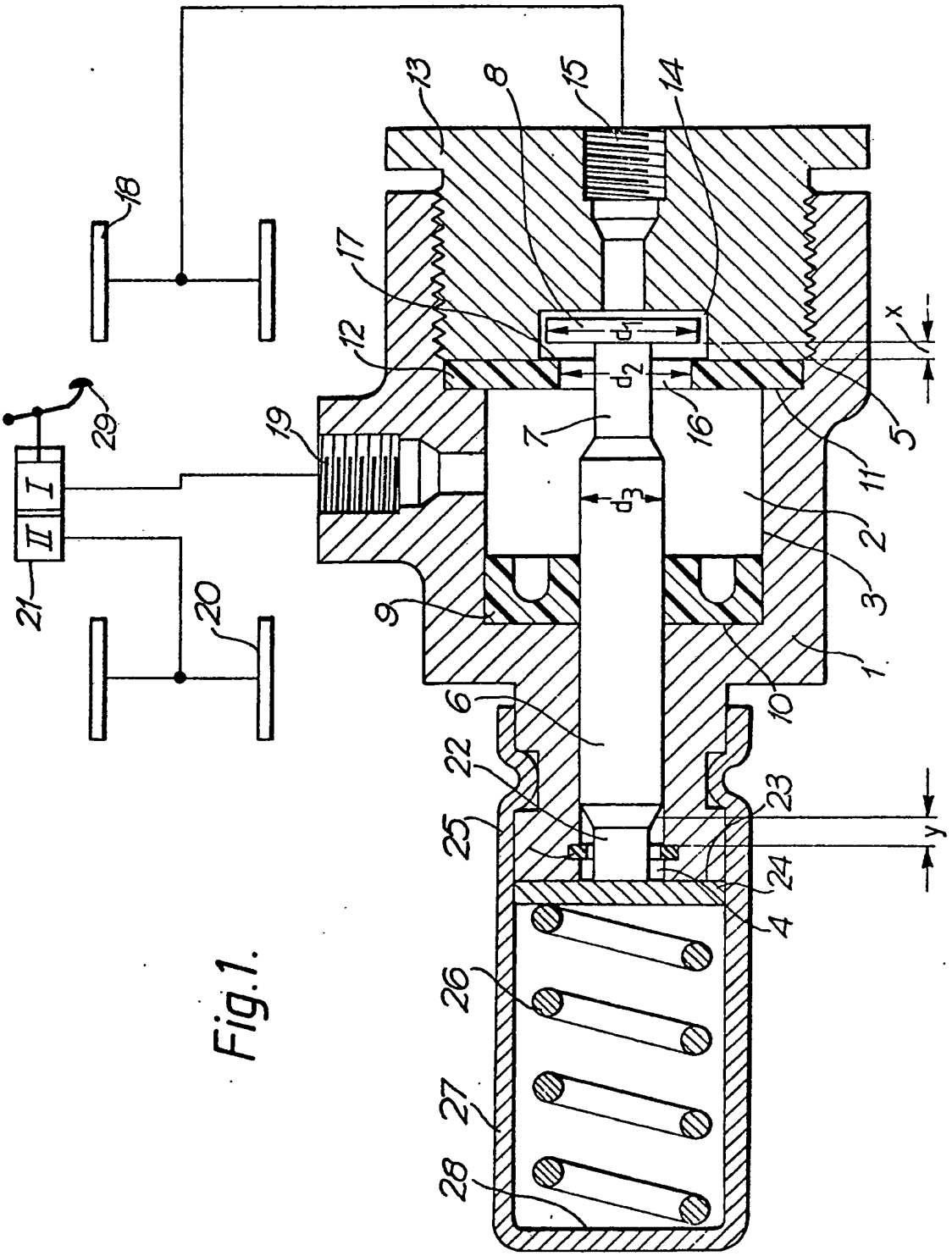
18
17
13
8
15
14
12
19
29
I
II
21
20
9
7
16
11
5
x
$d_1$
$d_2$
$d_3$
2
3
1
10
6
22
23
25
24
4
y
26
27
28

Fig.1.

Fig.2.

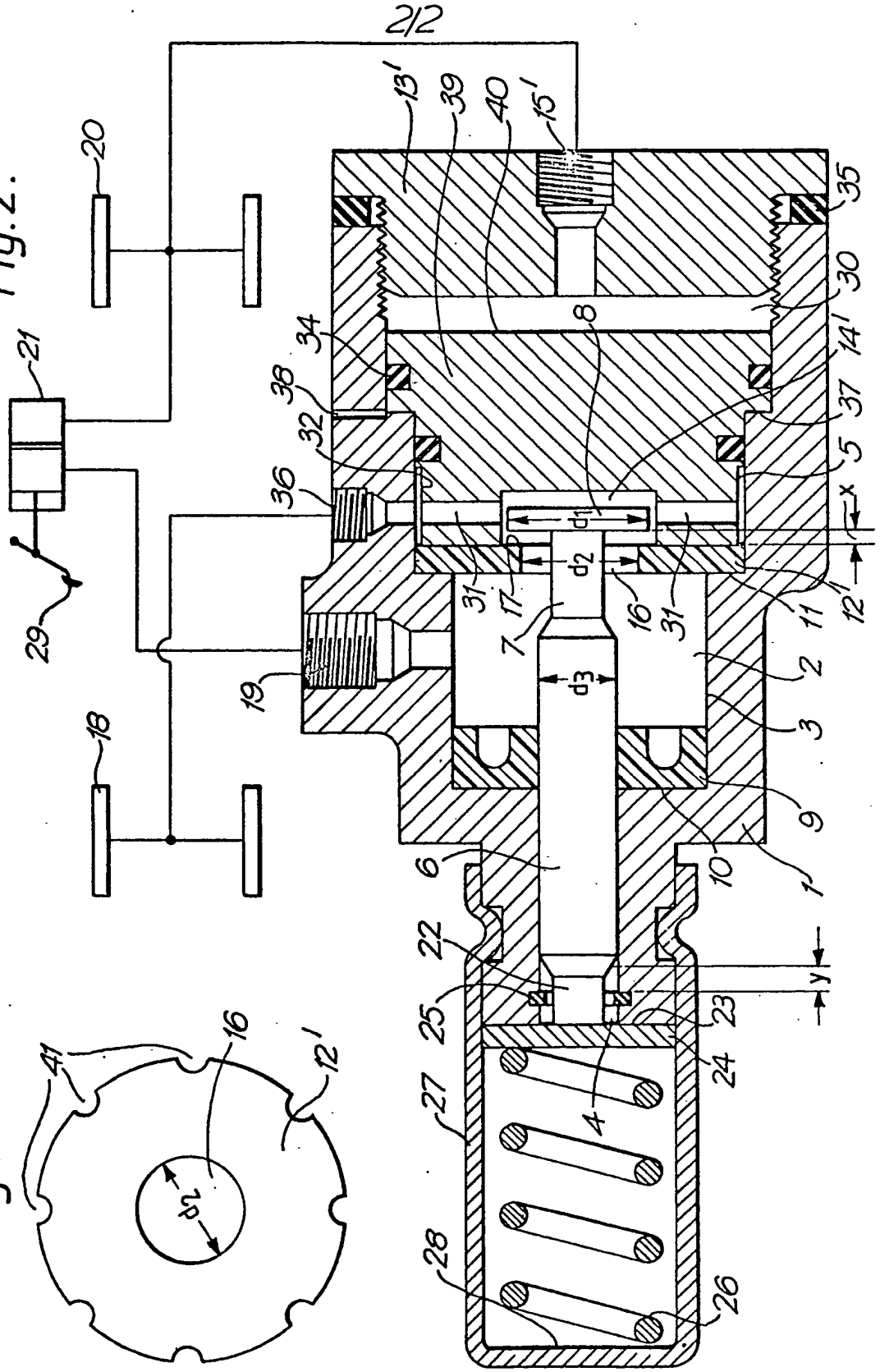
212
13'
39
40
15'
20
35
30
21
34
14'
38
37
32
5
36
x
d1
d2
29
31
17
16
31
11
12'
7
2
19
d3
3
18
9
6
10
1
22
y
25
23
24
27
4
28
26

Fig.3.


41
16
12'
d2

SPECIFICATION

**Brake Pressure Regulator**

This invention relates to a brake pressure regulator, in particular for a vehicle hydraulic brake system, including a regulator inlet chamber and a regulator outlet chamber connected with one another via a passageway in which a pressure control means is arranged, which control means consists of an elastomeric valve seat ring movable into the inlet chamber and being inserted between the regulator inlet chamber and the regulator outlet chamber as a sealing partition wall, the passageway being adapted to be closed by a valve member arranged in the outlet chamber and movable within limit stops and having its end surface close to the inlet chamber in abutment with a wall formed fast with the housing, with the exception of a narrow annular surface directly neighbouring the passageway, and subjected at least partly to the pressure of the outlet chamber when the passageway is closed.

A brake pressure regulator of the aforementioned type is known from French Patent Application No. 2,155,887. The housing of a pressure-reducing valve includes a bore in which the elastomeric valve seat ring, which is formed as a piston, is arranged to slide axially. The valve seat ring is urged against a bushing inserted in the bore by a spring bearing against the wall of the inlet chamber confronting the passageway. The bushing is urged against a circumferential shoulder in the bore wall by a plug tightly sealing the bore and is thus securely held in the housing. The valve member is seated on the end of a valve piston which, extending through the inlet chamber and the passageway, has its thicker end, which is opposite the valve member, guided to the outside through a bore provided in the wall of the inlet chamber opposite the passageway. The thick end of the valve piston axially sliding in the through bore carries in an annular groove an O-ring sealing the inlet chamber against the atmospheric-pressure chamber. The valve consists of a portion extending beyond the passageway and being connected with the valve piston via a conical section and closed by a section extending beyond the remaining diameters of the valve member. The inner wall of the bushing extends in a conically tapering manner towards the passageway, allowing the valve member to move out of the bushing until its largest-diameter section is in abutment with the inner wall of the bushing, thus limiting the closure travel of the valve. The bushing has bores extending through to its outer wall and terminating in a circumferential annular groove so that the pressure-fluid connection to the outlet port provided in the housing will be ensured. The piston is supported in such a manner that the effective surface subjected to the pressure of the outlet chamber is greater than the effective surface subjected to the pressure in the inlet chamber. When the inlet chamber is pressurized, the pressure therein will propagate through the passageway into the outlet chamber and when the pressure has reached a specific magnitude, it will move the valve member with the valve piston in opposition to a force acting on the valve piston from the outside towards the inlet chamber, until the conical section of the valve member comes into sealing abutment in the passageway of the valve seat ring. When the pressure is removed from the inlet chamber, a force will be exerted on the pressurized annular surface formed by the sealing valve seat and the inside diameter of the bushing which force axially displaces the valve seat ring against the spring force, thus lifting it off the conical shoulder of the valve member. The passageway is opened again and thereby the pressure reduction in the outlet chamber ensured.

It is a disadvantage in this known embodiment that in the presence of a pressure difference between inlet chamber and outlet chamber a relatively high force is needed to axially displace the valve seat ring. The force to be overcome is determined by the spring force urging the valve seat ring against the bushing and by the frictional force occurring between housing and valve seat ring which is relatively high since it is in sealing abutment with the housing wall.

According to the present invention there is provided a brake pressure regulator, in particular for a vehicle hydraulic brake system, comprising a housing including a regulator inlet chamber and a regulator outlet chamber connected with one another via a passageway in an elastomeric valve seat ring which is movable into the inlet chamber and is inserted between the regulator inlet chamber and the regulator outlet chamber as a sealing partition wall, the passagway being closable by a valve member arranged in the outlet chamber and movable within limit stops, the valve seat ring having its end surface close to the inlet chamber in abutment with a wall formed fast with the housing, a narrow annular surface of the valve seat ring directly neighbouring the passageway and on the outlet chamber end face thereof being subjected at least partly to the pressure of the oulet chamber when the passageway is closed, and wherein the valve seat ring is supported at its end surface close to the inlet chamber such that the valve seat ring will be deformed into the inlet chamber whereby to open the passageway when the pressure in the oulet chamber is greater than the pressure in the inlet chamber.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a section through a first embodiment of a brake pressure regulator,

Fig. 2 is a section through an embodiment of brake pressure regulator with by-pass,

Fig. 3 is an end view of a valve seat ring.

In Fig. 1, a housing 1 includes a triple-stepped through bore 3 in whose smallest-diameter section 4 a valve piston 6 is guided in an axially slidable manner. Valve piston 6 extends through medium-diameter section 2 and projects with its free end 7, which has a diameter smaller than that

of the majority of the valve piston and carries a valve plate 8, into the largest-diameter section 5 of stepped bore 3. A ring seal 9 sealingly embracing the valve piston firmly abuts step 10 of stepped bore 3, thus sealing off section 4 of stepped bore 3 against section 2, which serves as an inlet chamber. A flexible elastomeric partition wall comprising a valve seat ring 12 abuts step 11 of the stepped bore and is urged into sealing engagement with step 11 by a plug 13 screwed into section 5 of the stepped bore. A cup-like outlet chamber 14 with its outlet 15 coaxially arranged with the valve piston is housed in the plug 13 and has the valve plate 8 sliding therein axially with a small radial clearance. The plug 13 provides a bearing surface for the valve seat ring 12 with the exception of a small annular surface 17 directly neighbouring passageway 16, so that, with the valve closed, at least part of the annular surface will be subjected to the pressure of the outlet chamber 14. The outlet chamber 14 is connected with the wheel cylinders of the rear axle 18, the middle section 2 of the stepped bore 3, which serves as the inlet chamber, is connected with pressure chamber I of tandem master cylinder 21 via inlet 19. Pressure chamber II of the tandem master cylinder 21 is directly connected with wheel cylinders of a front axle 20. End 22 of the valve piston 6 pointing towards outer edge 23 of the housing 1 is smaller than the diameter of the majority of the valve piston so that section 4 of stepped bore 3 is able to accommodate a stop ring 25 which limits the axial displacement travel *y* of the valve piston in such a manner that it will be slightly longer than the valve closing travel *x*. Thereby it will be prevented that the valve plate 8 can be urged through the valve seat ring 12, which renders the brake pressure controller useless.

The end 22 of the valve piston 6 abuts a disc 24 which slides in a bushing 27 fitted to the housing 1. The disc 24 is urged against the housing outer edge 23 by means of a spring 26 bearing against bottom 28 of the bushing 27. The activated position of the arrangement is as shown.

The diameter $d_1$ of the valve plate 8 and the diameter $d_3$ of the valve piston 6 are dimensioned in such a manner that the pressure is reduced from the inlet chamber to the outlet chamber in the ratio of the surfaces subjected to pressure in the inlet chamber and in the outlet chamber. The diameter $d_2$ of the passageway 16 is larger than the diameter $d_3$ of the valve piston so that this arrangement can be mounted without widening the valve seat ring 12. The brake pressure regulator shown in Fig. 1 is a brake pressure reducer. It is, of course, also possible to employ the brake pressure regulator as a brake pressure limiter by arranging for diameter $d_3$ to equal diameter $d_1$. When the actuating pedal 29, the inlet chamber 2 will be subjected to pressure which propagates via the passageway 16, the outlet chamber 14 and the outlet 15 to the wheel cylinders of the rear axle 18 of the vehicle. From a specific pressure level onwards, the pressure acting on the effective area thereof in the outlet chamber will be sufficient to displace the valve piston to the left against the force of the spring 26 in order to close the passageway 16 by abutment of the valve plate 8 on the annular surface 17. The pressure regulator will reduce the pressure in the outlet chamber 14 according to the ratio of the effective areas in the inlet chamber 2 and outlet chamber 14 when the pressure in the inlet chamber 2 is increased further.

When the pressure in the inlet chamber 2 is decreased, the pressure in the outlet chamber 14 will move the valve plate 8 in the direction towards the inlet chamber 2 until the valve piston 6 comes into abutment with the stop ring 25. Through the remaining surface of the annular surface 17, which former surface is formed by the outer edge of the valve plate and the inner edge of the outlet outlet chamber 14 and is subjected to the pressure of the outlet chamber, a force is exerted on the valve seatring 12 causing it to be deformed into the inlet chamber 2 until the annular surface 17 has lifted off the valve plate 8 and opens the passageway 16 for pressure compensation. During pressure reduction in the outlet chamber, from a specific pressure level on, the force of the spring 26 will displace the valve piston to the right again until the inactivated position of the arrangement is regained.

Since the regulator design of Fig. 2 essentially corresponds to that of Fig. 1, like reference numerals have been used with the exception of the reference numerals marked with '. Section 5 of the stepped bore 3 extends at step 37 into a further, enlarged, section 30 closed by a plug 13' and tightly sealed off against atmosphere by ring seal 35 between housing 1 and plug 13-3.

Sliding in section 5 of the stepped bore is a stepped piston 39 which carries on both sides of step 37 ring seals 33 and 34, thus providing a fluid-tight seal between section 5 and section 30. The section between the seals 33 and 34 is connected with atmosphere via vent bore 38 so that a pressure compensation is allowed to take place as stepped piston 39 moves. In the section of the stepped piston 39 close to valve seat ring 12', is arranged the outlet chamber 14' which is in connection with a recess 32 of the stepped piston via radial bores 31. An outlet port 36 connected with the wheel cylinders of the rear axle 18 is provided in the housing 1 on a level with the recess 32. The pressure chamber I of the tandem master cylinder 21 is connected with the inlet 19 of the inlet chamber 2, the pressure chamber II of the tandem master cylinder is connected with the wheel cylinders of the front axle 20 and, via inlet port 15' in the plug 13', with section 30 of the stepped bore which serves as a pressure chamber.

As shown in Fig. 3, the valve seat ring 12' is provided with recesses 41 spaced over its outer periphery which are of a depth less than the height of the shoulder 11 serving as a support in the stepped bore 3.

When actuating the pedal 29, pressure fluid will be compressed equally in pressure chamber I and II. The pressure in pressure chamber II acts in section 30 of the stepped bore 3 on the larger surface 40 of the stepped piston 39, the pressure in pressure chamber I acts in the inlet chamber 2 on the smaller surface of the stepped piston. The stepped piston 39 thus subjected to pressure will be displaced to the left and urge the valve seat ring 12' against the step 11, until the stepped piston 39 abuts step 37. As in Fig. 1 the inlet chamber 2 and outlet chamber 14' are separated by a fluid-tight seal from each other, and when the pressure in chamber 14' is sufficient to move the valve piston 6 to the left, the pressure-reducing regulator becomes effective.

In the event of pressure in pressure chamber II failing, section 30 will become unpressurized. The stepped piston 39 when only subjected to pressure from one side, is displaced to the right, the sealing effect of the valve seat ring 12' on step 11 is lost and the pressure fluid, favoured by the construction of the outer periphery of the valve seat ring, is free to flow immediately to the outlet 36 via step 11. The pressure reduction is neutralized, and the total brake pressure produced by pedal force propagates to the wheel cylinders of the rear axle 18.

The valve seat rings (12, 12') of the present invention are supported at their end surface close to the inlet chamber and consist of such an elastic and elastomeric material that the valve seat ring will flap over to the inlet chamber and open the passageway in the presence of a difference of pressure between outlet chamber and inlet chamber. Thus the force needed to open the passageway when there is a difference of pressure between outlet chamber and inlet chamber is only dependent on the material used and the design of the valve seat ring and consequently reliably determinable within relatively close limits. The valve seat ring can be designed in such a way that even in the presence of very low differences of pressure between outlet and inlet chamber the valve seat ring will lift off the valve member.

Because in the embodiment of Fig. 1 the valve seat ring 12 is in abutment with the end surface of the plug 13, which end surface is on the side close to the inlet chamber, with the plug urging the valve seat ring towards the inlet chamber against a shoulder 11 in the housing, and because the outlet chamber has its outlet port arranged in the plug, a simple support of the valve seat ring is achieved enabling at the same time the pressure chambers to be sealed against the atmosphere. The plug need not be equipped with an additional seal.

In the particularly advantageous embodiment of Fig. 2, the valve seat ring is urged towards the inlet chamber into sealing engagement with the shoulder in the housing by the piston 39 forming with its first end surface a boundary for the outlet chamber and having its second end surface subjected to the pressure of the second brake circuit of the tandem master/cylinder. Thus the regulating/sealing arrangement is dependent on the second brake circuit, this being especially advantageous in dual-circuit brake systems for vehicles. If the pressure fails in the second brake circuit of the tandem master cylinder, the piston will release the valve seat ring between regulator inlet chamber and regulator outlet chamber, the pressure in the inlet chamber will displace the valve seat ring in the direction towards the outlet chamber and thus the sealing effect will be neutralized. The pressure in the inlet chamber will be delivered to the wheel cylinders of the rear axle without a pressure reduction occurring, thus achieving a higher braking effect there. Because the piston 39 is designed as a stepped piston, the larger end surface of which is subjected to the pressure of the second brake circuit and which abuts the step in the housing, thus limiting the compression of the valve seat ring, damage to the valve seat ring will be avoided. Designing the valve seat ring such that it includes recesses spaced over its periphery and being of a depth lower than the height of the shoulder in the housing serving as a support, ensures fluid flow through its outer periphery in the disengaged state of the valve seat ring.

The present invention provides a regulating/sealing arrangement which avoids the disadvantages of the prior art, affords ease of maintenance due to its simple design, and is economically priced.

**Claims**

1. A brake pressure regulator, in particular for a vehicle hydraulic brake system, comprising a housing including a regulator inlet chamber and a regulator outlet chamber connected with one another via a passageway in an elastomeric valve seat ring which is movable into the inlet chamber and is inserted between the regulator inlet chamber and the regulator outlet chamber as a sealing partition wall, the passageway being closable by a valve member arranged in the outlet chamber and movable within limit stops, the valve seat ring having its end surface close to the inlet chamber in abutment with a wall formed fast with the housing, a narrow annular surface of the valve seat ring directly neighbouring the passageway and on the outlet chamber end face thereof being subjected at least partly to the pressure of the outlet chamber when the passageway is closed, and wherein the valve seat ring is supported at its end surface close to the inlet chamber such that the valve seat ring will be deformed into the inlet chamber whereby to open the passageway when the pressure in the outlet chamber is greater than the pressure in the inlet chamber.

2. A brake pressure regulator as claimed in claim 1, wherein the valve seat ring is in abutment with an end surface of a plug on the side thereof close to the inlet chamber, the plug serving to urge the valve seat ring towards the inlet chamber against a shoulder in the housing,

and wherein the outlet chamber has an outlet port arranged in the plug.

3. A brake pressure regulator as claimed in claim 1, wherein the valve seat ring is urged towards the inlet chamber and into sealing abutment with a shoulder in the housing by a piston forming with a first end surface thereof a boundary for the inlet chamber and having a second end surface subjected in use of the regulator to the pressure of a second brake circuit of a tandem master cylinder.

4. A brake pressure regulator as claimed in claim 3, wherein the piston is a stepped piston, the larger end surface of which is subjected to the pressure of the second brake circuit, and wherein the stepped piston abuts a step in the housing, thus limiting the compression of the valve seat ring.

5. A brake pressure regulator as claimed in claim 3 or 4, wherein the valve seat ring includes recesses spaced around its outer periphery and of a depth less than the height of the shoulder in the housing which serves as a support therefor.

6. A brake pressure regulator substantially as herein described with reference to and as illustrated in Fig. 1 or Fig. 2 of the accompanying drawings.

7. A dual circuit brake system in a motor vehicle including a brake pressure regulator as claimed in any one of the preceding claims.

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